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Research Article

Effect of Cinnamon Administration on Fertility of Normal and Diabetic Male Rats

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Abstract

Background and Objective: Male infertility is one of the most common problem in the world. Diabetes is one of the chronic metabolic syndrome that was found to have direct effect on testicular malfunction. This study aimed to evaluate the enhancement effect of cinnamon bark powder on fertility parameters in normal and diabetic male wistar rats. **Materials and Methods:** A total of 40 male wistar rats were divided into two sets: normal and diabetic rats. Normal rats received either distilled water or 80 mg kg⁻¹ day⁻¹ of cinnamon only and diabetic rats received either distilled water or 80 mg kg⁻¹ day⁻¹ of cinnamon only. Cinnamon powder was suspended in distilled water. After four weeks all groups were euthanized and analyzed for testosterone, epididymis weight, sperm count, motility and morphology with proper technique. **Results:** The result showed that cinnamon as powder exerted significant changes on fertility parameters in both normal and diabetic rats including testosterone, epididymis, total sperm count, motility and sperm morphology (normal sperm count, abnormal head sperms, abnormal tail sperms). Also it was noticed that diabetic rats gain higher beneficial improvement changes in fertility parameters than normal rats. **Conclusion:** Ingestion of cinnamon bark found to improve significantly infertility parameters in both normal and diabetic male rats which may give promising solution to the problem, however more effective on diabetic than normal rats.

Key words: Cinnamon, epididymis, male infertility, normal and diabetic male rats, sperm count, sperm morphology, testosterone

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Globally, one of the major health problems in life is male infertility. Many factors may contribute to the problem, including hormonal problems and several diseases, which may conflict with the spermatogenesis¹. Some of the serious diseases that shoot out spermatogenesis are diabetes mellitus, chronic liver diseases and coronary heart diseases^{2,3}. Diabetes has been also shown to alter steroid hormonal levels as well and subsequently to diminish spermatogenesis^{4,5}. Consequences of diabetes could end up with macrovascular manifestations include atherosclerosis and microvascular consequences, retinopathy and nephropathy, are major causes of blindness and end-stage renal failure⁶. These consequences were attributed to the low synthesis of nitric oxide from endothelial cells of blood vessels due to the presence of high level of free radical⁷.

It is clearly documented that oxidative stress is an important process involved in multiple health conditions like inflammation, infertility and diabetes^{8,9}.

Oxidative stress is suggested to causes protein and DNA damage and plays a major role in the development of diabetes^{9,10}. It has been understood that increased cell dead signaling through mitochondrial membrane destruction is responsible for most of these changes and subsequent infertility^{11,12}.

Medicinal plants are used enormously to tackle many of health disorders and syndromes¹³⁻¹⁵. Cinnamon is one of these plants which is commonly used as food spice and medicinally as antioxidant, anti inflammatory and antidiabetic due to the presence of some phytochemical ingredients such as polyphenols¹⁶⁻¹⁸. Several scientific researchers reported that cinnamon extracts showed significant improvement in hyperglycemia, hyperlipidemia and fertility¹⁹⁻²³. It had been also observed that different extracts of cinnamon modulated the effect of oxidative stress in obese people with impaired fasting glucose²⁴⁻²⁶. Furthermore, it was also used as an alternative remedy for reducing the risk of infertility, cardiovascular diseases related to inflammation and other complications related to oxidative stress¹⁶. Cinnamon is found to possess some biochemical and physiological changes in the sites of resistance to insulin, transmission of glucose through cell membrane, enzyme system of carbohydrate metabolism and receptor sites^{15,27-29}. Previous literature focused on the effect of various cinnamon extracts, however, the present study was conducted to evaluate the effect of cinnamon bark powder on some infertility parameters in both normal and diabetic male rats.

MATERIALS AND METHODS

Animals: Forty adult albino male westar rats, 8 weeks old, weighing 230-250 g, were obtained from Jordan University of Science and Technology. Before processing the experiment, the animals were hosted under well-controlled conditions of temperature ($23 \pm 2^\circ\text{C}$), humidity ($45 \pm 10\%$), 12 h light/dark cycle and given access to food and water ad libitum. The rats were divided into two sets as normal and diabetic and divided into the following groups:

- **Group 1:** Normal rats received distilled water only
- **Group 2:** Normal rats received $80 \text{ mg kg}^{-1} \text{ day}^{-1}$ of cinnamon only
- **Group 3:** Diabetic rats received distilled water only
- **Group 4:** Diabetic rats received $80 \text{ mg kg}^{-1} \text{ day}^{-1}$ of cinnamon

To get diabetic animals, they were injected by alloxan intraperitoneally as 1.0 mL dose (150 mg kg^{-1} body weight for 5 days) before cinnamon treatment.

Preparation of cinnamon: The cinnamon was bought from a local market in Al Mafraq city as ground powder and was dispersed in 2 mL of distilled water and then be given orally at a concentration of 80 mg kg^{-1} daily for 4 weeks.

Experimental analysis

Measurement of testosterone: Blood samples were collected from the eye by plain capillary tube and centrifuged at 3000 rpm for 10 min by using hematocrit centrifuge and then kept in freezer until use. Total serum concentration of testosterone was measured using a double-antibody radioimmunoassay kit as manufacturer protocol.

Evaluation of infertility organs: At the end of time period, animals were anaesthetized with sodium pentobarbital (40 mg kg^{-1}) administered intraperitoneally and the peritoneal cavity was opened and the epididymis was immediately removed then weighed.

Sperm count, motility and morphology: For sperm counting, the cauda epididymis was cut and smashed with forceps to release sperms into 2 mL of medium ham's containing 0.5% bovine serum albumin. After 10 min of incubation at 37°C (with 5% CO_2), sperm count was achieved by using the standard hemocytometric method. Sperm motility was analyzed with a microscope at 10x magnification and was

Table 1: The effect of the cinnamon on serum testosterone, epididymis weight, sperm count and motility in both normal and diabetic rats

| | Normal rat | | | Diabetic rat | | |
|-------------------------------------|------------|-------------|------------|--------------|-------------|------------|
| | Before | After | Change (%) | Before | After | Change (%) |
| Testosterone (ng mL ⁻¹) | 2.84±0.85 | 5.40±0.74* | 90 | 1.96±0.72 | 4.64±0.91* | 130 |
| Epididymis (g) | 1.20±0.53 | 2.40±0.92* | 50 | 1.10±0.23 | 2.10±0.78* | 90 |
| Total sperm count/10 ⁶ | 36.30±5.09 | 54.71±8.33* | 50 | 24.37±8.12 | 41.54±9.54* | 70 |
| Motility (%) | 47.30±8.69 | 75.60±0.77* | 60 | 38.70±8.34 | 68.30±0.49* | 75 |

>Numbers are presented as Mean±SE, >*Significant different at p<0.05 level

Table 2: Effect of Cinnamon on sperm morphology (%) in normal and diabetic rats

| | Normal rat | | | Diabetic rat | | |
|--------------------|------------|-------------|------------|--------------|-------------|------------|
| | Before | After | Change (%) | Before | After | Change (%) |
| Normal sperm count | 93.76±1.88 | 97.55±1.56* | 5 | 84.12±1.87 | 94.43±2.19* | 12 |
| Abnormal head | 2.54±0.97 | 1.55±0.73* | 40 | 7.77±2.65 | 3.85±1.98* | 43 |
| Abnormal tail | 3.84±0.91 | 1.88±0.43* | 51 | 8.14±3.55 | 2.40±1.97* | 70 |

*Significant different at p<0.05 level

reported as the mean of motile sperm according to the world health organization method. Morphology of sperms was detected.

Statistical analysis: Collected data were analyzed using Two-way ANOVA. All statistical analyses were performed using the Statistical Package for Social Science (SPSS) version 16. Differences of p<0.05 were considered statistically significant.

RESULTS

The present study showed that cinnamon exerted significant changes in fertility parameters. Table 1 shows that level of testosterone significantly increased in normal (90%) and diabetic (130%) rats. Epididymis weight significantly increased in normal (50%) and diabetic (90%) rat. Total sperm count also increased in normal (50%) and diabetic (70%) rats. In addition, motility also increased significantly in normal (60%) and diabetic (75%) rats. Table 1 also shows that, before cinnamon treatment, diabetic rats showed lower values in all fertility parameters as compared to normal rats.

Data in Table 2 shows that normal sperm count increased from 5-10% in both normal and diabetic rats. Significant reduction in abnormal head sperms (~40%) in both normal and diabetic rats was observed. Moreover, 50% reduction in abnormal tail sperms in normal and 70% reduction in diabetic rats was also observed. Generally, it is noticed that diabetic rats gain higher beneficial changes in all fertility parameters than normal rats.

DISCUSSION

The present study showed that alloxan-induced diabetic male rats suffer from abnormal fertility measurements

including serum testosterone levels, epididymis weight sperm count, motility and morphology. These parameters were markedly improved after 4 weeks of cinnamon powder treatment.

It is well known that diabetes is positively correlated with male infertility and sexual dysfunction. This impairment occurred due to hormonal changes, neuropathy and increased oxidative stress aspects^{4,5,30,31}.

Positive effects of cinnamon on these parameters reported in the present study agreed with previous studies which used different cinnamon extracts^{3,20-22,32,33}. It was clarified that cinnamon phytochemistry as well as other medicinal plants-revealed the presence of various phytochemicals like alkaloids, flavonoids, tannins, saponins, steroid and glycosides in six solvents cold, hot, warm water, acetone, ethanolic and methanolic bark extracts³⁴⁻³⁶. Some of these constituents showed antidiabetic, anti hyperlipidemic as well as antioxidant ingredients such as polyphenolic which could be one that bleached the effect of oxidative stress^{9,37,38}. Highly significant improvement was observed in diabetic rats after cinnamon treatment, hence, it means that cinnamon is highly effective in resolving the issue of diabetes which is a major cause of infertility^{21,24,27,39}.

More impression in our data is the level of enhancement in fertility parameters in both normal and diabetic rats, however diabetic rats got more enhancement than normal rats. This is a novel result to compare the effect of cinnamon in normal and diabetic rats. Previous studies indicated that cinnamon extracts have significant effect on diabetic rats but with low or no effect in normal control rats¹⁹⁻²².

Our results, demonstrated higher effect of cinnamon on fertility parameters compared to previous reports^{3,21-24,39}. This effect can be attributed to the presence of many ingredients in cinnamon powder bark work together as synergistic

combination compared to those found in separate extracts. It could be deduced that taking cinnamon as food spice regularly might improve fertility even in normal health persons as well as diabetic patients.

SIGNIFICANCE STATEMENT

This study discovered the effect of powdered cinnamon that can be beneficial for fertility in both normal and diabetic rats and will help the researchers to uncover the critical areas of infertility that many researchers were not able to explore. Thus a new theory on correlation between the effect of medicinal plant and infertility in diabetic patients may be arrived at.

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